MARKED AMENDED SPECIFICATION

Page 6, second full paragraph:

In one embodiment of the present invention, a low pressure swing adsorption system is taught wherein flow movement and pressure pulse are influenced from the same pressure source. The pressure source may be a high pressure source or a low pressure sink. The system includes at least one vessel containing an adsorbent bed. An inlet (feed end) is coupled to the vessel by way of an inlet header and an outlet (production end) is coupled to the vessel by way of an outlet header. The inlet header and the outlet header of each vessel have a combined volume of less than approximately 20% of the volume of the adsorbent bed. Preferably, this volume is limited to less than 10% and most preferably to less than 5%. Each inlet is coupled to a high pressure source or a low pressure sink. This configuration is depicted in Figures 2a and 2b, discussed in detail below. It is notable that void volumes of less than about 20% of the adsorbent bed can be achieved in nearly all bed configurations except radial bed configurations. One skilled in the art would acknowledge that void volumes this low are not readily realized in radial bed configurations. For radial beds, the present invention can achieve void volumes of less than 50%.

On page 12, first full paragraph:

Second, more than one high pressure source and/or low pressure sink may be mounted proximate to, ~~a~~or nearly proximate to, each vessel, by suitably employing multiple inlets and/or outlets. These inlets and outlets improve flow distribution within the adsorbent bed headers and reduce header void space. For example, the ratio of the volume of the void space to the volume of the adsorbent bed is minimized. The resultant system has a reduced total void space as compared with the PSA systems taught in the prior art.

In the paragraph bridging pages 18-19:

Since the separation work in a PSA process is only done in the adsorbent, the rest of the void (i.e., non-adsorbent) volumes, such as distribution pipes and ~~ab~~adsorber headers, must be minimized for improved process performance. In conventional bed headers, a single inlet or outlet is normally used. A certain volume is needed for distributing gas flows from the inlet or outlet uniformly to the adsorbent for better use of the adsorbent and process performance. Multiple inlets or outlets can provide a better flow distribution and require less header volume. The number of inlets or outlets depends on a number of factors, for example, product flow, diameter/size of the bed, high pressure source/low pressure sink capacity, etc. If enough inlets or outlets are provided, the flow distribution header volume could be virtually eliminated and a quasi-flat header could be obtained as illustrated in Figure 2c. Compared with a conventional header, the flat header design can save up to 15-20% (and in some instances 5-10%) of the volume of a vertical bed configuration of a 150 TDP oxygen plant, and approximately 20-60% (and in some instances 10-20%) for a radial bed.

In the paragraph bridging pages 19-20:

Figure 2d shows a further non-limiting embodiment of the present invention using two flat header adsorbent beds 21 and 21' (with volumes V1 and V1', respectively) are connected to ~~to~~ a common high pressure source 27 (i.e., compressor) and/or low pressure sink 29 (for example, a vacuum pump) by way of distributed valves. Valves 36, 36', 37 and 37' represent inlets and may be mounted immediately proximate to the inlet headers 22 and 22' (with volumes





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V2 and V2', respectively). Likewise, valves 33 and 33' represent outlets and may be coupled proximate to the outlet headers 24 and 24' (with volumes V3 and V3', respectively). Valves 36 and 36' are connected to common distribution pipes D6 and share a low pressure sink 29. Valves 37 and 37' are connected to common distribution pipes and share a high pressure source 27. As in the embodiment of Figure 2d, ideally the distribution pipes D5 and D6 should be maintained at either high pressure or low pressure depending on whether they are connecting the high pressure source or low pressure sink, respectively, to the vessel. The valves can provide the multiple flow inlets and outlets required by a flat header, thereby reducing the header void volume. Three-way unloading valves (38 and 39) and distributed valves can be suitably employed to close the distribution pipes to pressure changes, for example during an idle step, and maintain either high or low pressure. Therefore, the distribution pipe volume (V4 and V7) does not contribute, or contributes little to, power loss and the total void volume. In this embodiment, one high pressure source and/or one low pressure sink may be sufficient for the entire system. Alternatively, multiple high pressure sources and/or low pressure sink may be employed.

In the paragraph bridging pages 20-21:

Figure 2d also depicts silencers S1, S1', and S2 with volumes V5, V5', and V8, respectively. These silencers contribute to intermediary volume V10 (not shown) along with distribution pipe volumes V4 and V7, and other miscellaneous volumes V6 (not shown). As discussed above, V6 includes all volumes and not solely silencers, that may be situated between the inlet and the pressure source(s) or on the production (outlet) end. In accordance with the present invention, these void sources may be limited to less than 20-15% of the total volume of the total adsorbent bed volume. Figures 3a and 3b depict a radial bed configuration also suitable in the present invention. Figure 3a depicts a top view of the bed and Figure 3b depicts a side view. Figure 3b shows a radial configuration where the high pressure source and/or low pressure sink, and valves are distributed along the circumference of the bed. In addition, the bed may be segmented (or divided, structured) as shown in Figure 4. Figure 4 depicts a segmented vertical adsorber configuration, wherein each segment functions as an individual adsorbent bed. Moreover, the beds may be very shallow and arranged in a parallel configuration where two adjacent beds (or compartments) share a common feed, evacuation and product withdrawal. The system can also be a vertical bed as shown in Figure 5.

Page 23, paragraph two:

By contrast, using the configuration disclosed in the present invention, the distribution pipes can be avoided as in Figure 2b, resulting in a reduction of the void volume to about 50%. Such a reduction increases recovery to about 25%, as indicated by case B1 in Figure 7. Furthermore, in the present invention, if two flat headers are used as shown in Figures 2c and 2d, the void volume can be reduced to a few percent of the adsorbent bed, resulting in a recovery of more than 50%, as indicated by case C2 in Figure 47. Thus, the present invention reduces cycle time while significantly improving recovery.





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MARKED AMENDED ABSTRACT PAGE

# LOW VOID ADSORPTION SYSTEMS AND USES THEREOF

Abstract of the Disclosure ~~Invention~~

A low void pressure swing adsorption system wherein flow movement and pressure pulse are influenced from the same source comprised of at least one hermetically sealed vessel containing an adsorbent bed with an inlet coupled to the adsorbent bed by way of an inlet header and an outlet coupled to the adsorbent bed by way of an outlet header. Void volume of the inlet and outlet headers can be limited to less than 20% of the adsorbent bed volume, preferably to less than 10%, and most preferably to less than 5%, by mounting high pressure source(s) and/or low pressure sink(s) proximate to, or nearly proximate to, the adsorbent bed/vessel. Low void volumes and reduced cycle times may be achieved in all bed configurations, including flat header beds, segmented beds, and vertical beds. Radial beds may be configured so that the void volume of the inlet and outlet headers is less than 50% of the volume of the radial adsorbent bed, preferably to less than 20%, and most preferably to less than 10%.





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MARKED AMENDED CLAIMS

5. (Once amended) The low void pressure swing adsorption system of Claim 1, wherein said at least one pressure source is a high pressure source.

6. (Once amended) The low void pressure swing adsorption system of Claim 1, wherein said at least one pressure source is a low pressure sink.

17. (Once amended) The low void pressure swing adsorption system of Claim 16, wherein said inlets share saida high pressure source connectedmounted to said valve and said distribution pipes are maintained at high pressure.

18. (Once amended) The low void pressure swing adsorption system of Claim 16, wherein said inlets share saida low pressure sink connectedmounted to said valve and said distribution pipes are maintained at low pressure.





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